Nepenthes macfarlanei: Prey found in ground pitchers

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Nepenthes macfarlanei grows in the mossy montane forest of western Malaysia. Its ground and hanging pitchers are quite different in shape and colour. Ground pitchers with large, deep-red peristomes are often embedded in thick *Sphagnum* carpets (Figure 1). The upper part of the pitchers (peristome and lid) barely emerge from the moss layer.

In 1993 I had the opportunity to investigate some pitchers of *Nepenthes macfarlanei* on the mossy crest of Mount Brinchang (Cameron Highlands). In the following, I only mention animals found several times in the pitchers.

Hexapoda (insects)

Cockroaches (cf. *Ectobius*, Figure 2): These quick, mostly nocturnal insects are omnivorous. They like to make contact with their surroundings (which is called thigmotaxis). These animals climb without any difficulty over smooth surfaces with their pulvilli (small cushions on the legs with an adhesive function). It is astonishing that these animals are victims of *Nepenthes*! Their orientation is based on their antennae touching the environment incessantly. These antennae are the main source of tactile and chemical information. Therefore, it seems that cockroaches fall accidentally into the pitchers. But there is another question: Does the rotting material (digested animals with their smell) attract cockroaches (see also Cheek (1992))? Smaller beetles can also be found in pitchers, but in a lot of

Figure 1: Ground pitcher of *Nepenthes macfarlanei* embedded in *Sphagnum*.

Figure 2: Cockroach (cf. *Ectobius*)

ground pitchers, ants are by far the dominant prey (see discussion about ants by Erber (1979)).

Chilopoda (centipedes)

Scutigera (Figure 3) and *Scolopendra* (Figure 4, p50): Both of these centipedes have many legs and are extremely mobile, and are nocturnal. They are ground animals and predators which catch their prey by venomous claws. *Scutigera* also catches food with its long legs. It is one of the fastest centipedes. *Scutigera* has compound eyes, whereas *Scolopendra* is characterized by few ocelli. The activity of

Figure 3: Centipede (*Scutigera*)

these centipedes is correlated with hunger. Food (prey) is perceived by tactile and chemical receptors on mouth parts, legs, and antennae.

Arachnida (spiders and mites)

Spiders (Figure 5, p50) have in most cases several eyes, chemoreceptors, and systems highly sensitive to tactile stimulation and vibration. It is now known that even nocturnal spiders have a good home-finding ability, in both distance and direction. Terrestrial mites feed in various ways, and tactile receptors predominate. It is well known that some spiders and mites live in the pitcher. Therefore, it is difficult—without greater knowledge of the species—to distinguish between animals that have accidentally fallen into the pitcher and animals living normally in pitchers and dying there.

The prey in ground pitchers mentioned above show some common characteristics:

- They are very good runners.

- They are wingless arthropods (except the cockroaches and beetles).

- They are predators (except nectar collecting ants and omnivorous cockroaches).

- They achieve orientation by chemical and tactile receptors (except spiders with few ocelli).

- They exhibit nocturnal activity (except ants).

The conclusion of these facts is that the predators probably fall accidentally into the pitchers. Their populations must be well developed in the *Sphagnum* layers and regenerate quickly. The role of the decaying, smelling organic matter in the pitchers is unclear. Though my investigations are not quantitative, I will discuss some phylogenetic aspects here.

Suppression of pitchers

It is well known that some species of *Nepenthes* possess only ground pitchers (*N. rhombicaulis, N. "rosulata"* (This last name is invalid, but is being used to denote plants of *N. gymnamphora*—ed.)) or only short shoot pitchers (*N. ampullaria, N. pervillei*). Their long shoot pitchers are suppressed or not developed. This may be caused especially by shade or nitrogen rich soil (see Smythies (1965); Green (1967); Schmid-Hollinger (1979)). But this reduction of hanging pitchers may also be forced through selective pressure by absent prey. In biotopes with few flying insects it seems more economic to give up hanging pitchers. These reflections are not in contradiction to the models of Givnish (1984) (see Juniper *et al.* (1989)). Givnish shows that the cost-benefit analysis of carnivorous plants is rapidly negative in shady places. In shady places the sizes of the *Nepenthes* leaves are often enormous. The photosynthetic parts of the leaves are large and very long. If we follow Givnish, we may explain this excessive growth as due to minerals gained in ground pitchers which enhance leaf growth.

Why such elaborate ground pitchers?

Ground pitchers in mossy forests are successful! As we saw, big insects like cockroaches and centipedes were caught. Ground pitchers show many exciting features: large, intensely coloured peristome, teeth and nectar. But the above cited arthropods do not react to colours, they orient through chemical receptors. A simple funnel without luxurious accessories would have the same effect on these mostly nocturnal arthropods. A possible answer to this conflict may be that the present successful relationship between ground pitchers and ground arthropods is of secondary nature.

In *Nepenthes mirabilis*, Jebb (1989) found similar prey. But he found cockroaches and centipedes also in upper pitchers. It is understood that these arthropods are also good climbers (see also the comment on Jebb by Cheek (1992)).

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Figure 4: Centipede (*Scolopendra*)

Figure 5: Spider as prey

From the pages of CPN 25 years ago

Greenhouse pests plagued a new member (all members were new back then!): "Isamu Kusakabe has noticed that cats are apparently attracted by odor to his *Drosophyllum*. They break into the greenhouse and step all over his other plants in order to get to *Drosophyllums* [*sic*]. He and we would be interested to know if anyone else has observed this phenomenon."

And for perhaps the first time in print, we learned how to obtain pollen from *Byblis gigantea*: "Warren Stoutamire noted that the flower has a structure similar to some non-carnivorous plants that require vibration of the anthers by the wings of bees and other insects for dehiscence to occur. Joe Mazrimas tried this and obtained abundant pollen."